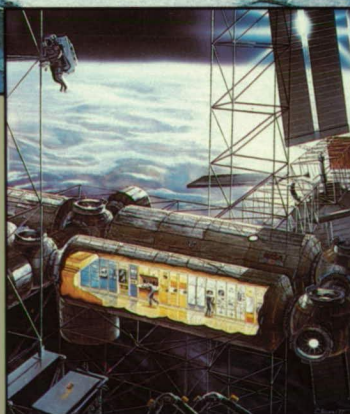
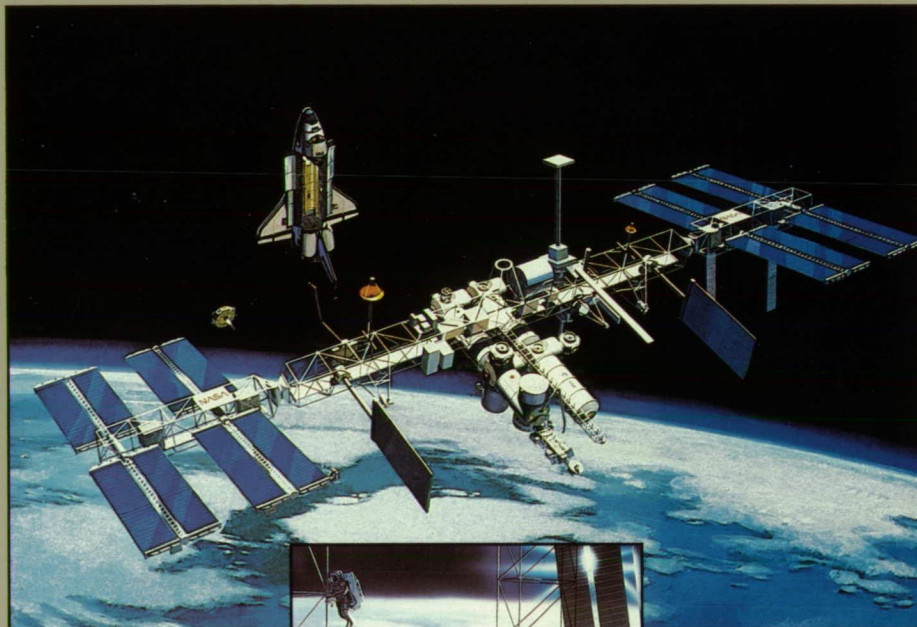


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FOR THE  
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*Life Science will be one of the pacing technologies for long duration manned spaceflight. The ability to effectively deliver state-of-the-art inflight medical care will have a major impact on crew health and mission success. NASA has a major commitment to minimize the medical risk for Space Station and beyond—and the Space Station Health Maintenance Facility is a major step in that direction.*

—Dr. James Logan



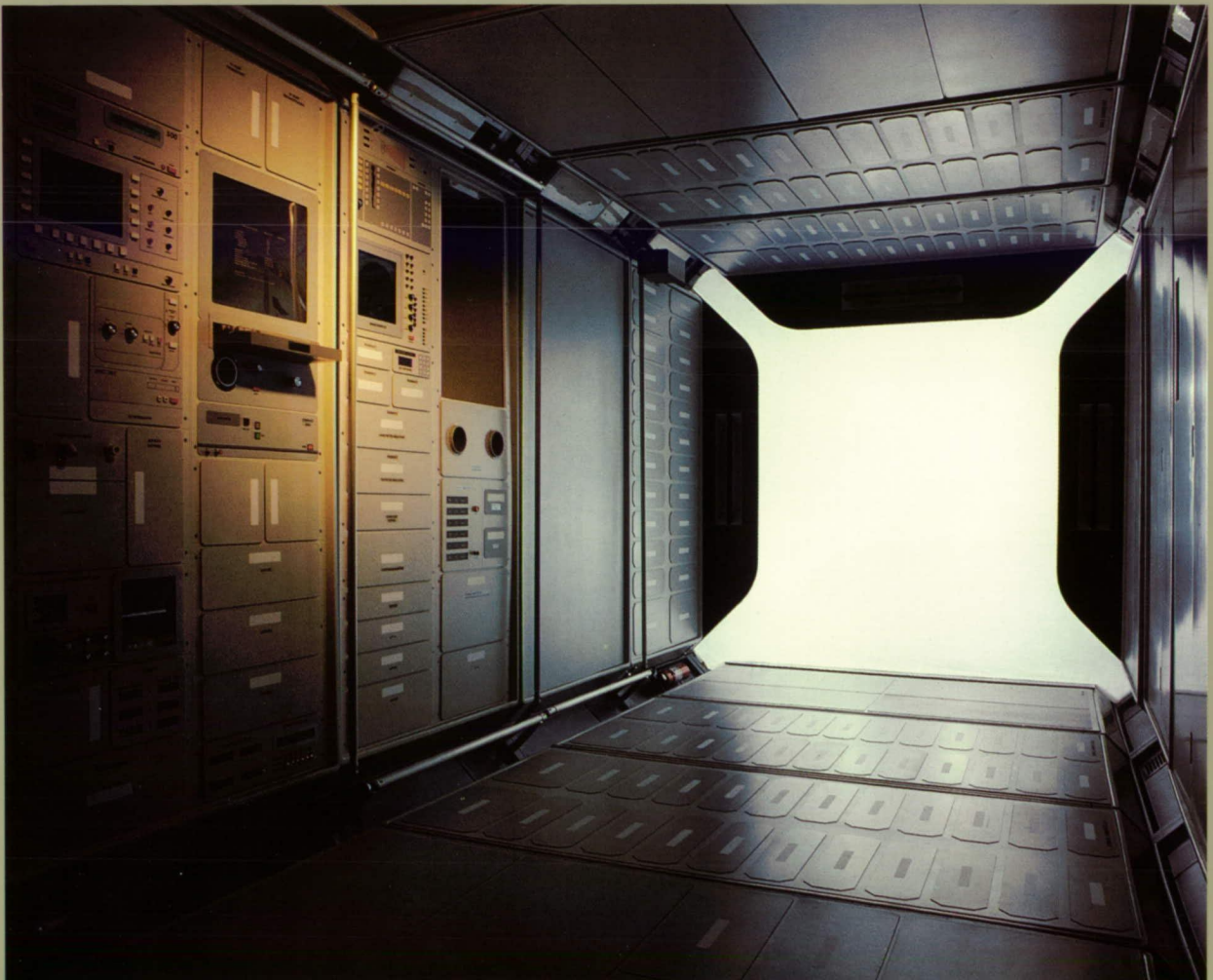
### The Space Station Era

**S**ince 1950, the United States has pursued an ambitious program to explore and utilize space. One of the most important steps in this program will take place within the next decade with the establishment of a permanently manned space station.

**T**he Space Station will serve as a home, workplace, and scientific laboratory for highly trained astronauts and scientists. Ultimately, the Space Station will serve as a staging area for the construction of a Lunar Base and for long missions to Mars and possibly deep space.

The Space Station crews will participate in missions of extended duration with limited capability for emergency return. This factor alone places

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great responsibility on program designers to ensure the health, safety, and well-being of the crews. The Health Maintenance Facility (HMF) under development at the Johnson Space Center is a key element in the fulfillment of this responsibility.

### A Goal-Oriented Facility

**I**n comparison to previous spaceflight missions, the complexity of providing health care for the Space Station crewmembers will be greatly increased. Contributing to this complexity will be the opportunities for individuals to participate as crewmembers who are not astronauts—individuals who, as a result, may be subject to less stringent physical standards. To ensure the health and well-being of the crews and the success of the Space Station missions, the HMF is designed to achieve three important goals.

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Experience has shown that long-term exposure to the space environment contributes to some physiologic changes in crewmembers. As a result, the need for careful monitoring and the development of appropriate countermeasures are essential elements to the success of Space Station missions. The *first goal* of the HMF is to provide effective methods to monitor crewmember physical fitness and to counteract the detrimental effects of living in space.

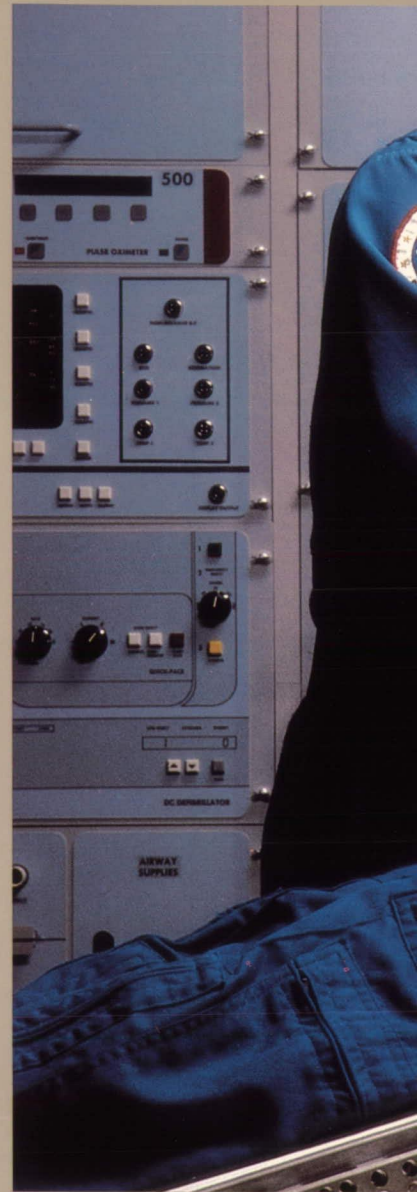
**E**xperience has also shown that in spite of preventive measures illness will occur among crewmembers. In addition, the



major construction efforts that will be an integral part of the Space Station program may greatly increase the risk of physical injury. These illnesses and injuries may range from simple maladies to life-threatening conditions. The *second goal* of the HMF is to provide definitive diagnostic and treatment capabilities to avoid the need for a rescue mission.

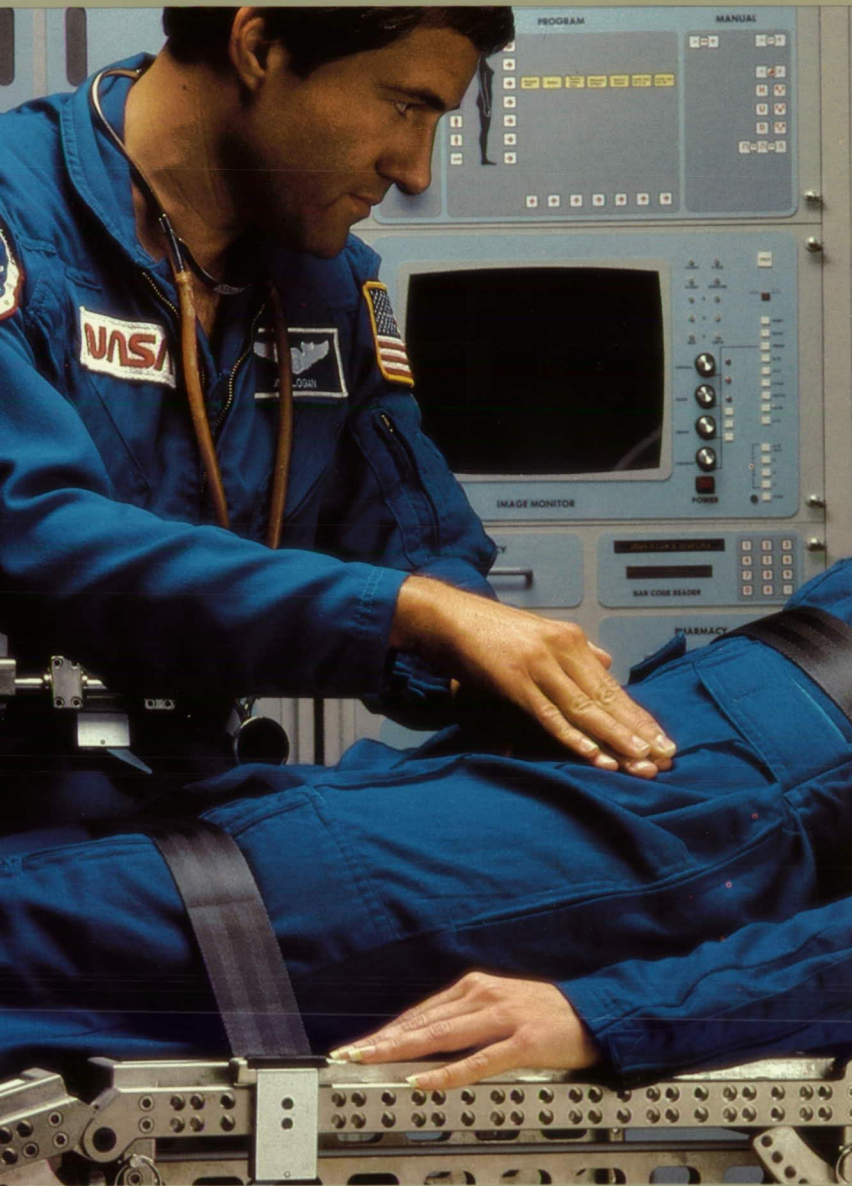
A rescue mission would be both costly and difficult. Once a decision is made to attempt a rescue, it is estimated that it would take from 14 to 45 days to launch with a cost of up to 200 million dollars. If, however, rescue is the only alternative, the *third goal* of the HMF is to preclude deterioration of the crewmember's condition and to make the return to Earth as comfortable as possible.

**I**n addition to serving these three goals, the effort performed as part of the HMF program will offer major contributions to medical science. This effort will help to establish physiological norms for spaceflight and to develop valuable technology for use within the general medical community.



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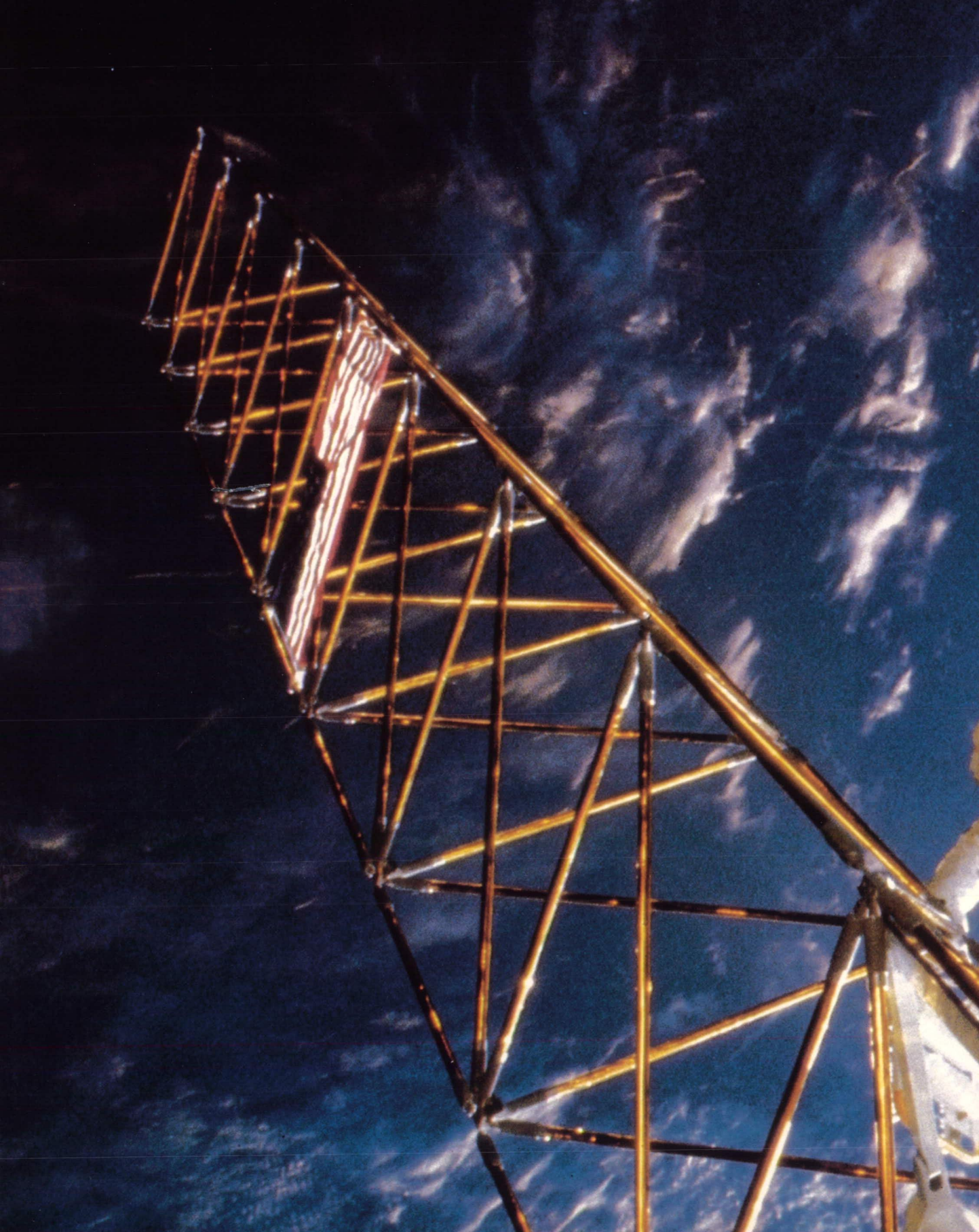




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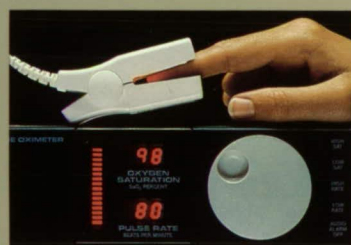






## A Unique Life Sciences Resource

**P**roviding quality health care is a challenge even in the most sophisticated medical facilities. The unique environment of the Space Station makes the task more challenging and requires both innovative thinking and inventive engineering. Because of the limited size of the Space Station, the HMF is being developed within restrictive space and weight parameters. The equipment used in the HMF must be able to operate in microgravity and must be able to return to normal operation following exposure to the vacuum of space. In addition, it is possible that the crews will not include a physician. Those crewmembers serving as medical officers may have limited training. As a result, the equipment must be user-friendly and maintenance free.





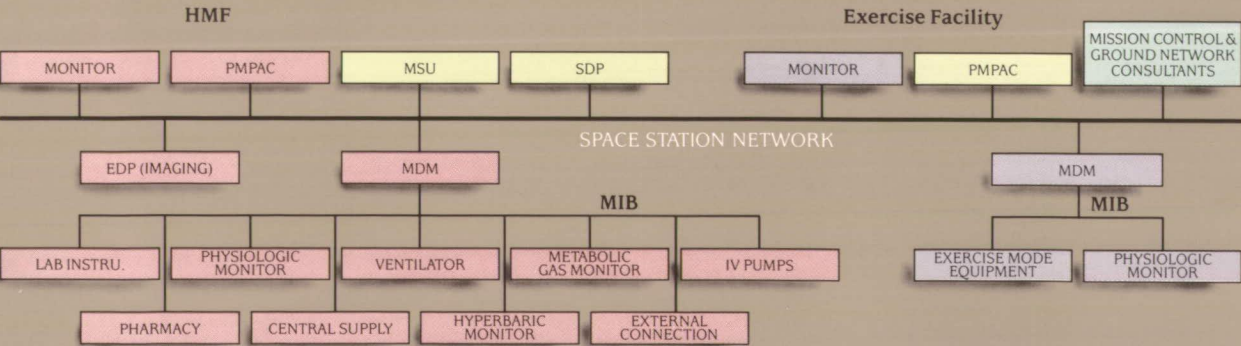


**T**he HMF is composed of a number of integrated subsystems, each of which serves a specific purpose in achieving the facility's over-all goals. Each subsystem is a modular, self-contained unit linked to a specially designed central computer system through a Medical Information Bus (MIB). The Computer System supports a sophisticated data management system capable of performing several key functions: it integrates information from the HMF subsystems; maintains crew-members' electronic medical records; transmits and receives medical data to and from Earth; and stores a variety of protocols to be used for the prevention, diagnosis, and treatment of medical conditions.

The HMF subsystems include a Hyperbaric Treatment Facility complete with treatment tables, protocols, and instrumentation to treat decompression sickness and/or barotrauma such as air embolus. The HMF Exercise Countermeasures subsystem will be utilized to prevent the adverse effects of microgravity on bone and muscle tissue through carefully designed exercise protocols. The Pharmacy subsystem will supply needed drugs and medications. It will provide inventory control and the necessary security measures for controlled drugs.

**D**iagnosis of medical conditions will be supported by an Imaging subsystem with full-service radiographic imaging capabilities, including transmission and reception of images to and from ground facilities. The HMF Clinical Laboratory subsystem will house the instrumentation to perform clinical chemistries, hematology, dissolved gas analysis, and a variety of other tests that may be required. A Consultants' Ground Network subsystem will offer two-way access to specialty consultants throughout the United States. If required, these consultants can be called upon to advise and direct diagnosis and treatment.

The Medical Information Bus links the varied HMF subsystems (as indicated below) and a sophisticated computer system which maintains records, transmits and receives medical data, and stores a range of valuable information.



EDP—Embedded Data Processor  
MDM—Multiplexer Demultiplexer  
MIB—Medical Information Bus  
PMPAC—Portable Multi Purpose Applications Console  
MSU—Mass Storage Unit  
SDP—Standard Data Processor





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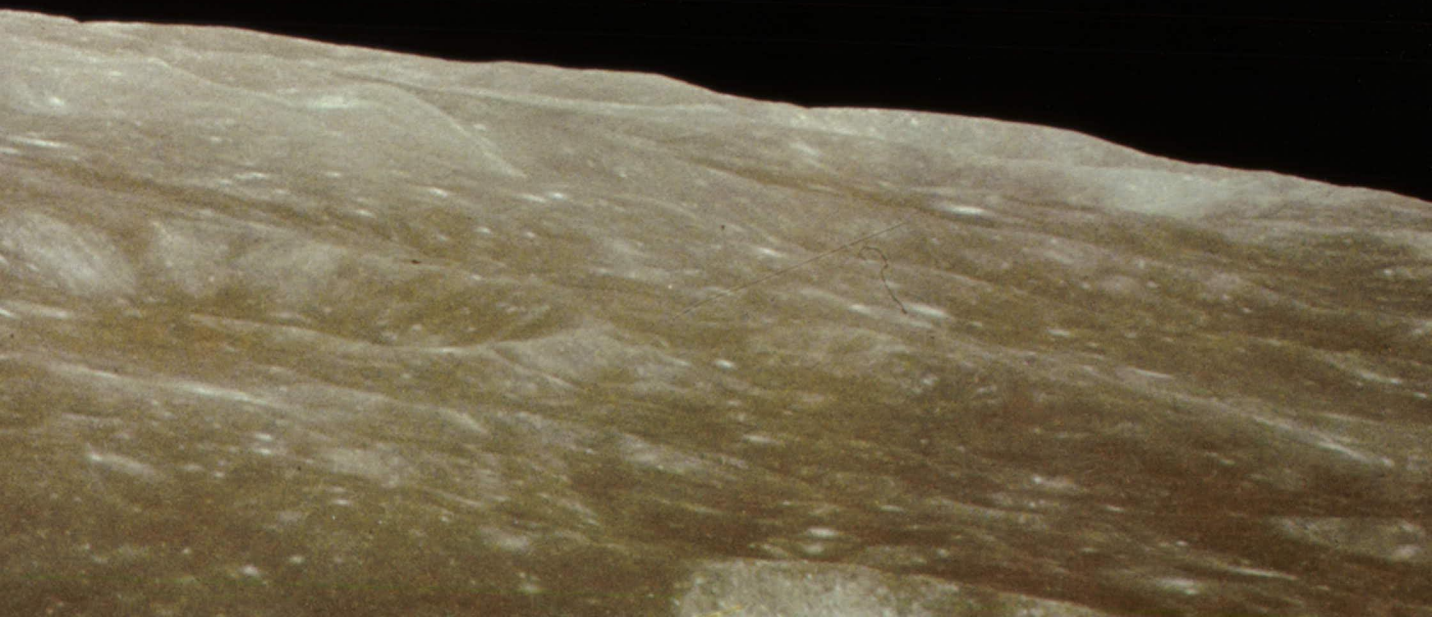




**D**efinitive treatment of a variety of medical conditions will be aided by the Intravenous Fluid Therapy and Nutritional Support subsystems which will administer both short-term intravenous medication and fluid therapy as well as long-term nutritional support. The Medical Life Support subsystem will have conventional "crash cart" / ICU capabilities and the instrumentation to monitor vital signs and electrophysiologic parameters. The Ventilation Support subsystem will be utilized to mechanically assist breathing. If the rescue of an ill or injured crewmember becomes necessary, several HMF subsystems will contribute to the probability of the patient's survival by being transportable.









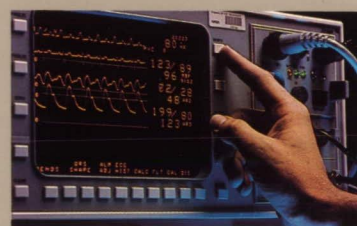
## NASA Meeting the Challenge

**H**ealth care problems encountered in the Russian space program, in exploration of the Antarctic, and in the U.S. Navy's nuclear submarine program, all lend emphasis to the need for health care delivery in a remote environment. NASA is leading the way to meet this need through the design and implementation of a flexible, integrated health care system—the Space Station Health Maintenance Facility. The flexible modular design of this facility will permit ready hardware exchange to keep pace with advancing technology and changing requirements. The HMF will be a dynamic system. It will incorporate the most efficient, state-of-the-art technology throughout the life of the Space Station.

**N**ASA is committed to the use of clinically accepted standards of medical practice. Where possible, off-the-shelf equipment will be used in the Space Station program; however, much of the medical technology on the market today relies on gravity

to function. As a result, alternative methods will have to be developed for application of this technology in micro-gravity. Many standard medical monitoring procedures practiced in Earth-based clinical settings are invasive and, therefore, may be inappropriate for the space environment. NASA is already a leader in developing and implementing non-invasive technologies which will be used in the HMF.

NASA is on the leading edge of aerospace medical science and is meeting the challenge of the Space Station era and beyond. NASA is proud of the role that the Health Maintenance Facility will play in reducing the medical risk aboard the U.S. Space Station.



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National Aeronautics and  
Space Administration

Life Sciences Division  
Office of Space Science and Applications  
National Aeronautics and Space Administration  
Washington, DC 20546

Medical Sciences Division  
Lyndon B. Johnson Space Center  
Houston, TX 77058

Man-Systems Division  
Lyndon B. Johnson Space Center  
Houston, TX 77058

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Houston, TX 77058

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